Type I Progress Report No. 8
February 1974 - March 1974

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a. Title. The Interdependence of Lake Ice and Climate in Central North America

b. Proposal Number. 113

c. GSFC ID Number. P506

d. Problem Areas. None.

e. Accomplishments. Progress during the reporting period was not as great as had been anticipated because of illness to the investigators and a delay in renewing the investigation's GSFC computer account. However, most of the projected work for the reporting period was completed on schedule. Analysis of ERTS 1 imagery for the 1973 thaw season has been essentially completed; only a few swaths from late June remain to be viewed. Air temperature data from 14 weather stations in Manitoba and western Ontario have been loaded onto a tape file for use in computing running mean temperatures. Eventually this file will include data for the freeze and thaw seasons of 1961, 1963, 1972 and 1973. This will permit a more quantitative comparison between the movement of the transition zone and regional climatology than has been possible in the past.

f. Projected Work. During the next bi-monthly reporting period a major emphasis will be placed upon correlating the results of the ERTS 1 imagery analysis with observational weather data for the 1973 thaw season. The air temperature data file will be completed along with the computation of running mean temperatures. All results are scheduled to be reported in the fourth bi-annual progress report.

g. Results. The positions of the ice decay boundary (IDB) and thaw transition zone for the first half of the 1973 thaw season have been reported previously [1,2]. The results contained herein represent the northerly migration by the transition zone for the remainder of the thaw season. In compliance with the numbering scheme introduced in Reference 2, relative positions of the IDB and transition zone are shown in Figures 4, 5, and 6.

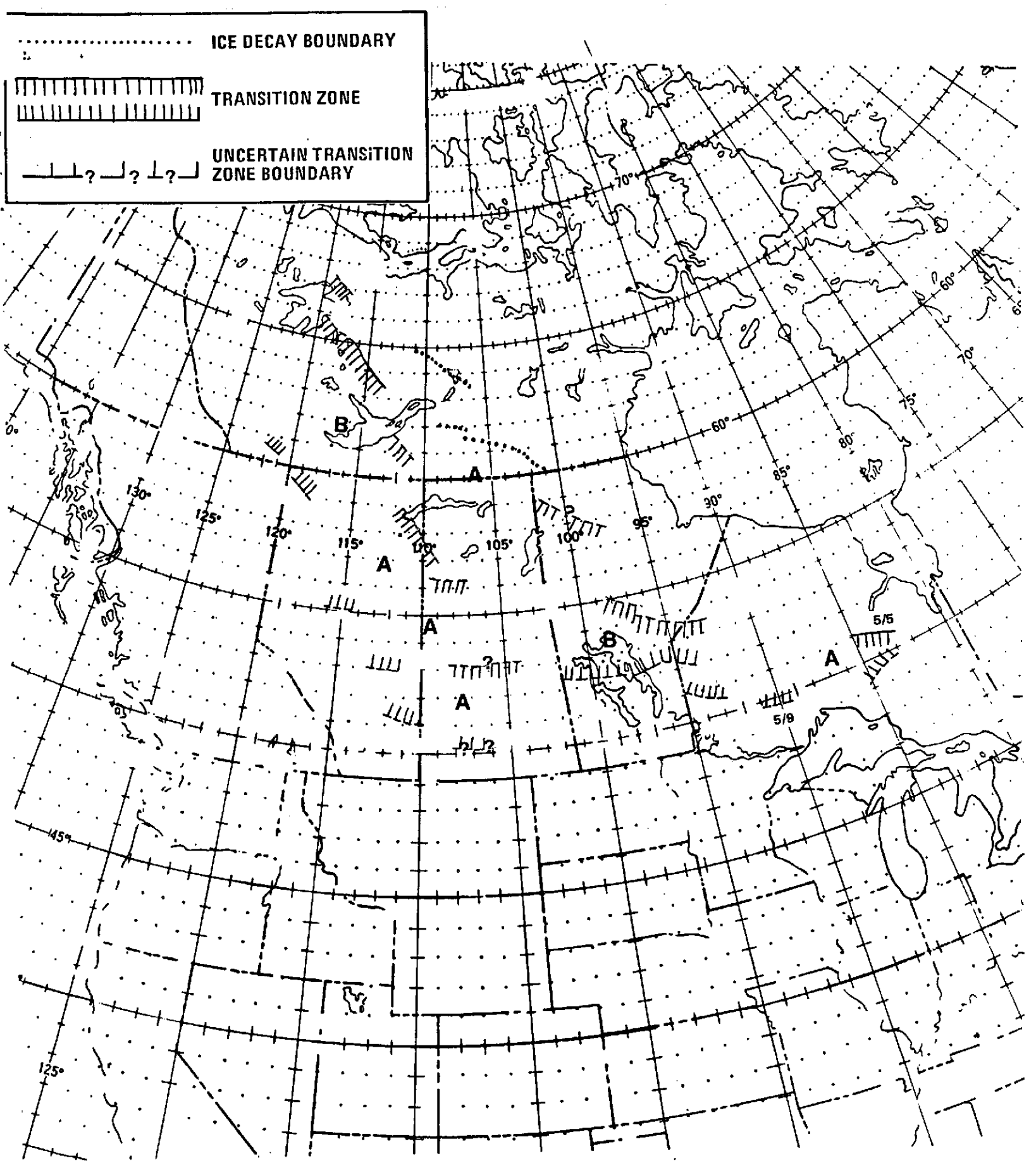

FIGURE 4. THAW TRANSITION ZONE BOUNDARIES AND ICE DECAY BOUNDARIES FOR EARLY TO MID-MAY 1973. PERIODS OF OBSERVATION:

A. 03 MAY – 09 MAY
B. 11 MAY – 19 MAY

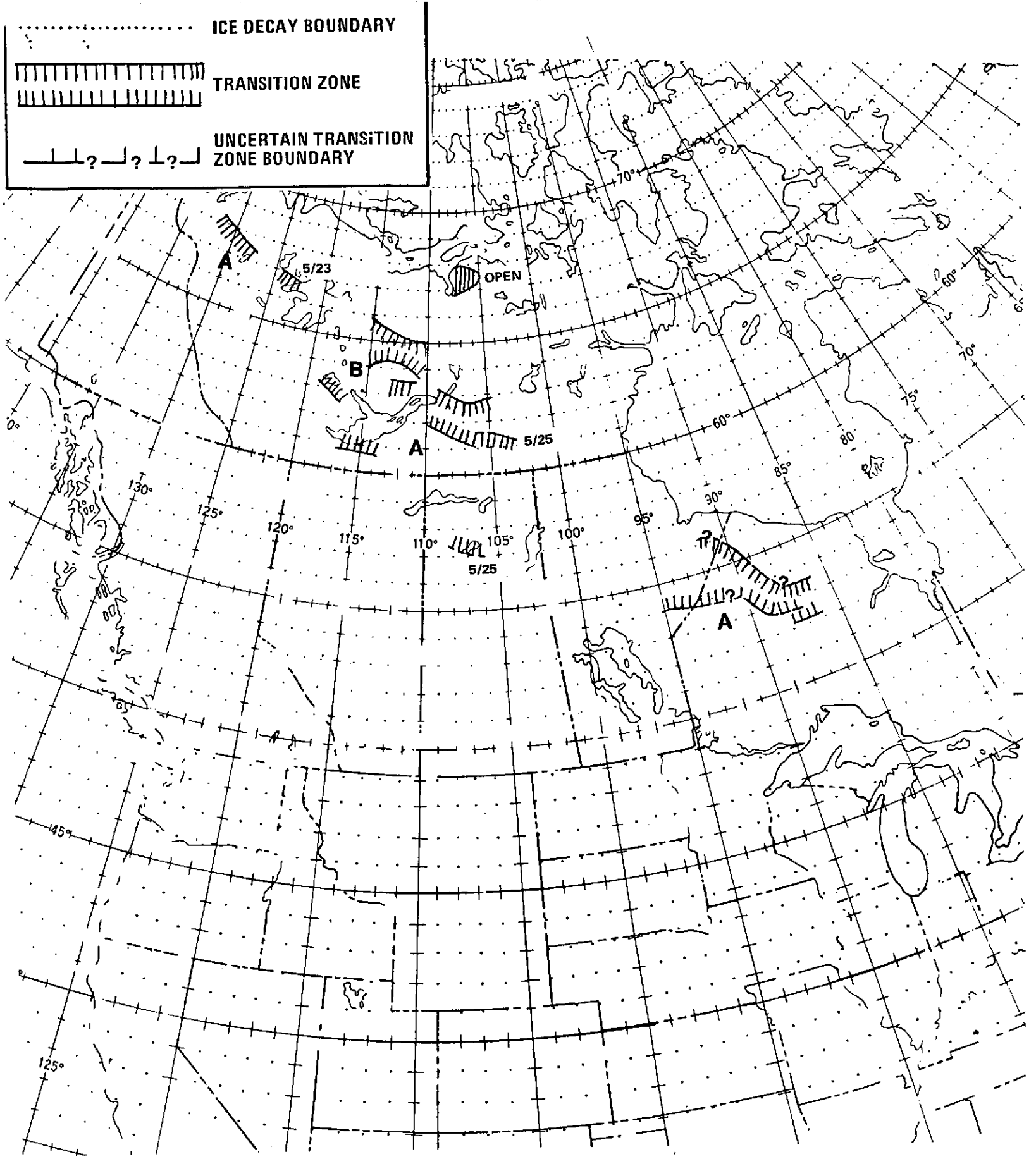

FIGURE 5. THAW TRANSITION ZONE BOUNDARIES FOR LATE MAY AND EARLY JUNE 1973. PERIODS OF OBSERVATION:

A. 26 MAY – 30 MAY
B. 01 JUNE – 02 JUNE

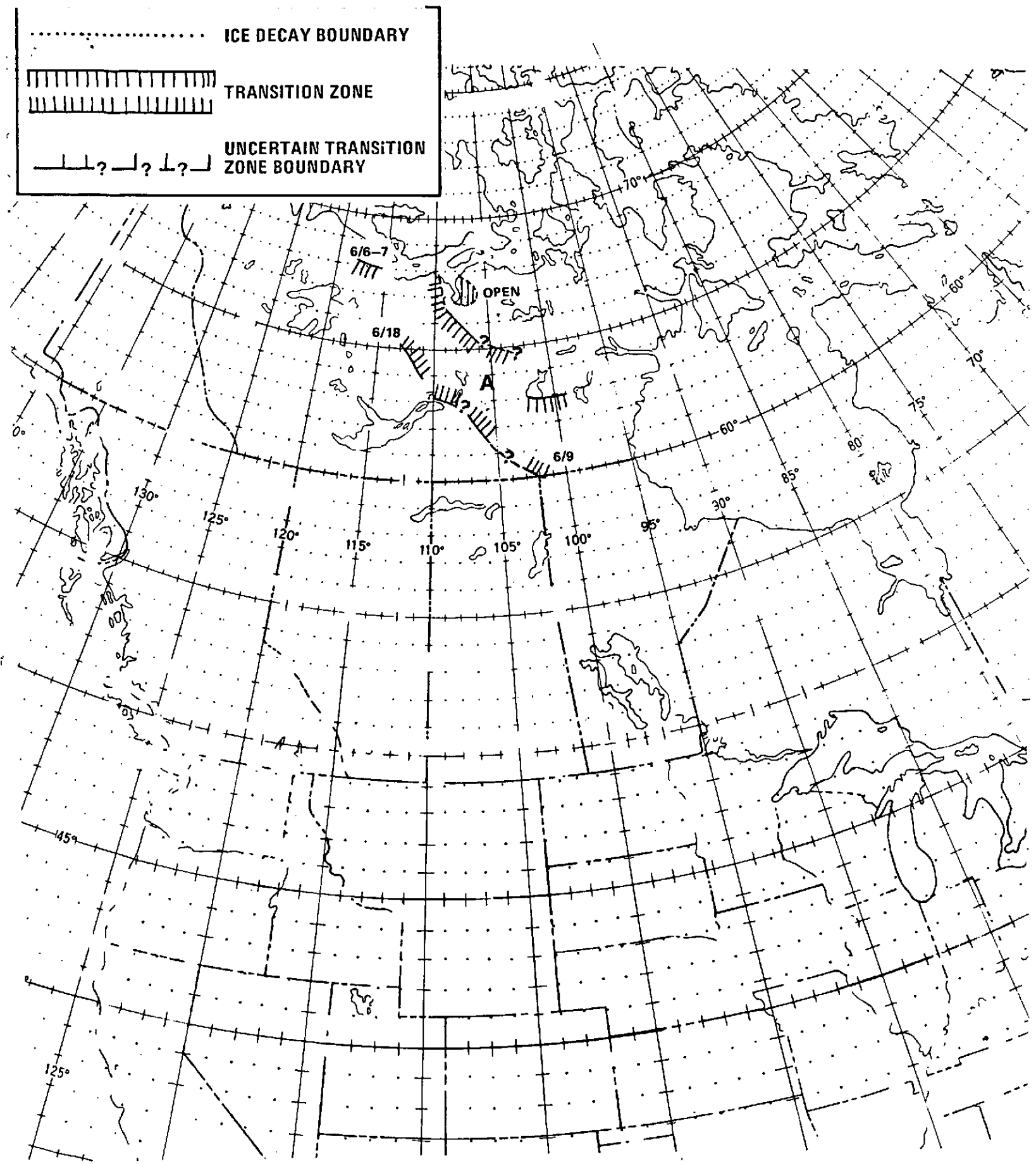

FIGURE 6. THAW TRANSITION ZONE BOUNDARIES FOR MID-JUNE 1973. PERIOD OF OBSERVATION:

A. 06 JUNE – 18 JUNE

One confusing feature of the figures is the abrupt discontinuities in the locations of the IDB and transition zone from day to day or swath to swath. The locations are reported as determined from ERTS 1 imagery, and no attempt has been made to smooth the data. An explanation has been offered previously [2] to the effect that the discontinuities denote a real day to day change in the ice conditions of lakes near boundaries in response to rapid and intense climatological changes. While this explanation probably accounts for some of the discontinuities, especially those involving the IDB, it would be highly unlikely to account for all. Other explanations are equally as feasible. For instance, during the thaw season the northern transition zone boundary (NTZ) is marked by the northernmost ice free lakes. Typically, these are the smallest lakes discernable on the imagery (~2km^2), and the determination of ice state can be quite subjective. Thus, in some cases, the discontinuities represent interpretive variances between analysts.

Another questionable feature of the figures is the abrupt shift in orientation of many of the boundaries. On a consecutive day basis, a boundary may change from essentially east-west orientation to almost north-south (e.g., Figure 4). As before, both objective and subjective factors may be the cause. In areas where the density is low, relatively few lakes mark any boundary, and, given the finite field of view of the imagery, a variety of boundary orientations are possible.

As mentioned earlier, the observational data are in an unmodified state and represent the combined efforts of two analysts working separately. Despite the unrefined nature of the data, some notable trends are apparent. Most striking of all is the wide variation in the location of the transition zone as a function of longitude. For example, consider Figure 4 on which the transition zone is defined for the last week of May. At that time the NTZ intersected the Beaufort Sea near the mouth of the Mackenizie River, Northwest Territories, while in Ontario the NTZ still lay many kilometers south of Hudson Bay. Almost 15 degrees of latitude separated the extreme ends of the transition zone. A suggestion of a northwest-southeast orientation of the thaw transition zone is shown in some figures by McFadden [3], however, to our knowledge this is the first time the orientation has been documented over the zone's full length.

Thus the thaw transition zone displays a remarkable similarity in migration pattern to the freeze transition zone [3,4]. This result is somewhat unexpected, because it had been assumed that two different mechanisms controlled lake freezing and thawing: (a) running mean air temperature in the autumn, and (b) solar irradiation in the spring. The two mechanisms should lead to different transition zone orientations. Since that is not the case, some re-examination of lake freeze-thaw mechanisms is required.

Comments or interpretations of the fine structure displayed in Figures 4,5, and 6 would be presumptuous without a detailed review of the ERTS imagery. However, one small feature deserves mention here, and that is the area of ice free, small lakes to the east of Bathurst Inlet (Figures 5 and 6). This area of prematurely open lakes is especially notable because it coincides almost exactly with an anomalous area of ice free lakes observed during the 1972 freeze season [4]. Apparently the lakes of this area have a much shorter ice cover period than other lakes in the vicinity. Although a number of explanations for this phenomenon are possible, any one proffered at this time would be extremely speculative.

References

1. Jelacic, A.J., The Interdependence of Lake Ice and Climate in Central North America, Interim Report, June-November, NASA Contract NAS 5-21761, 27p., 1973.

2. Wolf Research and Development Corporation, Type I Report No. 7, NASA Contract NAS 5-21761, February 10, 1974.

3. McFadden, J.D., The Interrelationship of Lake Ice and Climate in Central Canada, ONR Contract Nonr 1202(07), Tech. Report No. 20, 120p., 1965.

4. Jelacic, A.J., The Interdependence of Lake Ice and Climate in Central North America, Interim Report, December - May NASA Contract NAS 5-21761, 29p., 1973.

h. Publications. None.

i. Recommendations. None.

j. Standing Order Form Changes. Standing order expired. No longer receiving imagery on a regular basis.

k. Data Request Forms. One, dated 22 February 1974.

l. Image Description Forms. One.